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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/SE92/00369 (22) International Filing Date: 1 June 1992 (01.06.92) (30) Priority data: 9101682-4 3 June 1991 (03.06.91) SE (71) Applicant (for all designated States except US): REGAM MEDICAL SYSTEMS AB [SE/SE]; Regementsvägen 5, S-852 38 Sundsvall (SE). (72) Inventor; and (75) Inventor/Applicant (for US only) : NELVIG, Per [SE/SE]; Kalmarvägen 4, S-852 65 Sundsvall (SE). (74) Agents: HEDBERG, Åke et al.; Ludwig Brann Patentbyrå AB, Box 1344, S-751 43 Uppsala (SE).		(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), CS, DE, DE (European patent); DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (Eu- ropean patent), GN (OAPI patent), GR (European pa- tent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, ML (OAPI patent), MN, MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, RU, SD, SE, SE (Euro- pean patent), SN (OAPI patent), TD (OAPI patent), TG (OAPI patent), US. Published With international search report.
(54) Title: METHOD AND DEVICE FOR TRIGGERING OF X-RAY IMAGE SENSOR		
(57) Abstract The present invention demonstrates a method and a device in the technique of using an image sensing member, preferably a CCD cell instead of a film sensitive to X-ray radiation. The method and the device is applicable to a general X-ray arrangement without any necessary direct connection between the image sensing member and the X-ray arrangement has to be present by using a number of detector points for X-ray radiation at or in the CCD cell. Additionally is demonstrated a method and a device resulting in minimizing of the radiation dose to exactly what is needed for exact imaging exposure of an image, which according to the present invention implies that more images may be obtained within a same total normal radiation dose.		

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Method and device for triggering of X-ray image sensor.Technical field

The present invention relates to an improved method of triggering and an improved arrangement of X-ray detection at an image sensor for electronically producing X-ray images, and more specifically a method and an arrangement which except true triggering of the image sensor also limits the X-ray radiation dose when using a type CCD X-ray imaging cell as well as possibility for simple direct control of the X-ray apparatus.

Background of the invention

X-ray examinations normally have so far been conducted by putting the examined organ between an X-ray sensitive film and an X-ray source and radiating X-rays. Film exposed in this way being developed in a normal manner, will show different blackening dependent of the type and amount of tissue between the X-ray source and the film.

The method among other things has a drawback that it is not simply reproducible, but images made during what may seem to be same conditions may present very different blackening and resolution of the interesting areas of the organ being examined. Further the method is labor and time consuming as the result is achieved only after developing of the film.

Within the field of dental X-raying there is now also an application using for example a CCD cell similar to that in an ordinary video camera. This CCD cell is put instead of the X-ray sensitive film in an appropriate manner in the oral cavity of a patient behind the tooth or teeth to be examined, whereby an image direct from the CCD cell may be achieved on a display by means of known technique in the art by using an electronic interface and an ordinary PC computer. This has the advantage that the result is immediately obtained and if this image is not adequate a new exposure may immediately performed.

This technique generally relies on that the control electronics of the CCD cell itself has an electrical connection to the X-ray apparatus, such that the electronic interface receives information when the X-ray radiation is activated. This implies that such an arrangement has to particularly be adopted to each available type of X-ray equipment to implement this type of synchronization.

When X-ray images are produced by an image sensing member in the shape of a CCD cell at existing temperatures, e.g. in the oral cavity, dark currents exists which all the time are adding up charges within the CCD cell. These charges are added up so fast that the image sensing member will normally be saturated after one or a few seconds. From this reason the CCD cell must be emptied of charges before the exposure by X-rays is started. When the X-ray image is fully exposed it must immediately be read out in its totality not to loose image information due to the adding of dark currents.

Such a synchronization may be achieved by either activating the X-ray tube short before the scanning is started or for example the CCD cell or that the scanning is initiated from the X-ray arrangement, eventually with a delay such that the radiation source has come to full power. In both cases there is a general demand of considerable interfacing equipment to achieve this or otherwise the exposure time of the X-ray source must be chosen unnecessary long to ensure a good result.

According to the state of the art it is not unusual to willingly overexpose a bit to be certain of an acceptable result of the X-ray examination. One problem which then additionally has to be solved is that the accumulated radiation dose of the patient has to be optimized to be able to in this way minimize radiation dose to the patient, which is utterly important from the general standpoint of radiation protection.

A radiation sensor for dental X-ray examination is known from the German utility model G 89 09 398.4.(EP-A1-0 415 075). The imaging device then has a single radiation detector, placed in front of, at the side of or behind the imaging device. The single radiation detector as such may comprise one or more phototransistors having a scintillation layer. One drawback in such an arrangement is that the single radiation detector may be shaded by, for example bone or a tooth when the imaging device is placed into the oral cavity of a patient and thus will detect very little radiation as bone or a tooth will still be very opaque to the kind of X-ray radiation used for dental examination. Additionally the device is using only remote electronics for processing the obtained signals which gives a low efficiency for utilizing the small current generated in the scintillation layer of the radiation sensor.

Description of the invention

The invention is based on the technical possibility by means of a simple control equipment to deactivate the source of radiation after it is started, by a method of detecting radiation using several sensing diodes at the back of a CCD device or the multitude of charging pixel capacitors within the CCD device, triggering may be effected when the radiation source is activated and a measure that a sufficient radiation dose producing the desired imaging has been obtained.

A first object of the present invention therefore is to teach a method which does not demand a complex interfacing to each individual X-ray equipment e.g. for dental X-ray, the technique using preferably a CCD cell, and a direct connection between the image sensing and the X-ray apparatus will normally not be needed.

A second object of the present invention is to teach a method improving adaption of the exposure of the X-ray image at the image sensing member such that scanning of the image immediately

starts when sufficient exposure reliably has been detected or that the scanning starts immediately as the radiation of X-rays ceases.

A third object of the present invention is to teach a method implying that the radiation dose is minimized to exactly what is needed to satisfactory expose an image by using a signal from the arrangement to be able to deactivate the X-ray apparatus, implying according to the present invention that more images may be obtained within a same total normal radiation dose.

Another object of the present invention is to provide an arrangement of an X-ray image sensor according to the improved method, triggering the X-ray image sensor by the arrangement when the X-ray radiation is activated and deactivated by sensing X-ray radiation by using several detection points and thereby measuring the overall dose.

A further object of the invention is that the present arrangement is optimizing the exposure by sensing the total radiation dose and initiating the scanning out of image data from the image sensing member when sufficient exposure has been obtained.

Another further object of the present invention is to provide an arrangement according to the method of the present invention, minimizing the radiation dose to the patient in connection with an X-ray examination due to that the arrangement is producing an external signal which in turn may be used for the control of the deactivation of the X-ray apparatus.

Description of the drawings

The present invention will be described in a preferred embodiment by means of the attached drawings in which

Fig. 1 demonstrates a cross-section in part of the encapsulated image sensing arrangement of an preferred embodiment,

- Fig. 2a demonstrates the image sensing member of the encapsuled arrangement from above,
- Fig. 2b demonstrates the rear side of the image sensing member of Fig. 2a,
- Fig. 2c demonstrates the front side of the image sensing member of Fig. 2a, and
- Fig. 3 demonstrates a diagram of the electronic circuitry of interfacing units according to the invention.

A preferred embodiment

In Fig. 1 is demonstrated a preferred embodiment for dental X-ray of an arrangement 1 to be inserted into the mouth of a patient. The arrangement in the preferred embodiment comprises a CCD cell supplied and controlled by lines 6 seen in Fig. 2a. For dental X-ray the arrangement 1 is positioned such that the specific tooth or teeth is/are between the front side (upper side in Fig. 1) of the arrangement 1 and an X-ray radiation source. The CCD cell of the arrangement 1 then will be exposed differently dependent of the opacity for X-ray radiation of the tooth or teeth and thereby an X-ray image of the tooth or teeth is obtained in the CCD cell according to the state of the art.

Fig. 2c demonstrates the side having an image sensing member 5, for example, in form of a CCD cell lying on a base formed by a substrate or a printed circuit board, whereby the member 5 is turned towards the tooth or teeth during the X-ray examination. In Fig. 2b the rear side of the substrate or printed circuit board is shown, on which in the preferred embodiment three sensor elements 2, 3 and 4 are scattered over the surface. The sensor elements constitute detector diodes having a scintillation portion and are in the preferred embodiment of type BPW 34 produced by Telefunken. It is essential that these detector diodes 2, 3 and 4 are placed such that they do not hide any

portion of the image surface at the same time as those must be within the area of the maximum radiation dose. Therefore those are preferably spread on the rear side of the image sensing member. Consequently the number of detector diodes must be more than two to ensure that at least one diode may be put into a position where it will be accessed by not too a reduced X-ray radiation. In a first embodiment shown therefore are used at least three detector diodes 2, 3 and 4 connected in parallel. In another embodiment of the invention the CCD cell itself is used also as the sensor of X-ray radiation as it is consisting a large number of individual storage capacitances formed on the semiconductor substrate and these individual capacitors will be charged due to the incident photons of the X-ray radiation. When these capacitors are charged a certain amount of current will flow to or from the CCD device, which integrated current when exceeding a certain threshold will be used as a detection criteria.

In Fig. 3 is shown an electronic circuitry indicating the connection of the detector diodes to an interfacing electronic unit in the preferred embodiment consisting of two portions 10 and 20. The interfacing electronic unit portion 10 is integrated together with the detector diodes 2, 3 and 4 at the rear side of the image sensing member 5 of the preferred embodiment, while the other portion is found in an external electronic unit (not shown) and connected to the portion 10 by the connecting lines 6. Instead of the signal from the detector diodes 2, 3 and 4 the charging current signal from the CCD device is used in the other preferred embodiment of the invention and connected to the input of the electronic unit 10.

The interfacing unit portion 10 besides the detector diodes 2, 3 and 4 or the CCD device itself, comprises two operational amplifiers 12 and 15, resistors 13, 14 and 16 and a capacitor 17. Further the cathode side of the detector diodes are connected to signal ground via a point 18. The operational amplifiers of the preferred embodiment is of type TL072 produced by Texas Instruments Corporation.

The interfacing unit portion 20 also comprises two operational amplifiers 23 and 28 and resistors 22, 24, 27, 29, 30, 32 and 56 and capacitors 21, 25 and 36. Additionally the resistor 30 is connected to -12 V at a point 31. The interfacing unit 20 further comprises three semiconductor diodes 26, 33 and 34. Additionally the interfacing unit portion 20 has a signal output A. The operational amplifiers 23 and 28 of the preferred embodiment are of type TL072 produced by Texas Instruments Corporation while the diodes 26, 33 and 34 are of type BAS16 produced by Philips.

From the interfacing unit portion 20 signals go to an additional electronic unit in the form of a logic device generally denoted 40 and from which only a small portion is shown. The logic device 40 is of type XC3030-44, produced by XILINK, San Jose, California. The logic device also comprises a read and write memory in the shape of a RAM, in which, for example, any user program may be loaded to define the different logic functions obtained by this circuit, among other things, for its other functions like clocking of the CCD cell when reading out image data, which does not constitute a part of the invention as such but is known for a person skilled in the art. The demonstrated portion of the logic device 40 has one input A and two outputs B and C. The portion of the logic device 40 shown in Fig. 3 comprises buffers 41, 42, 43 and 45, the buffers 42 and 45 having an inverted output. Besides the buffer 43 is a three state output buffer, having high, low and floating states. The high and the low states, respectively, correspond as usual to logic one and logic zero, respectively. Additionally there are AND gates 44, 49 and 52 having two inputs, where AND gate 44 and 52 each are provided with an inverted input and the AND gate 44 additionally also has an inverted output. The portion of the logic device 40 shown further comprises an OR gate 50 and a D-type flip-flop circuit 51. The D-type flip-flop circuit is also provided with a clocking input 55. The buffers 41, 42, 43, 45 and the gates 44, 49, 50 together form a monostable circuit which is triggered from the input A. The time constant of the monostable circuit is set forth by the resistor 46 and the capacitor 48.

In the table below is given the values of the resistors and capacitors shown in the circuit diagram of the preferred embodiment of Fig. 3.

Resistor		Capacitor	
13	10M	17	330 pF
14	100K	21	10 μ F
16	1M	25	1,5 nF
22, 29	220K	36	1 μ F
30	820K	48	47 nF
24	2,2M		
27	2,7M		
32	1,8M		
46	560M		
56	150R		

In brief the function of the circuitry is as follows. When any of the sensor elements 2, 3 and 4 is subject to X-ray radiation it will produce a current which is fed into the input of the first operational amplifier 12. In the same way when the CCD device is subject to an X-ray radiation it will produce a current due to the charging of the individual capacitors constituting the individual pixel elements, which current alternatively is fed to the first operational amplifier. This amplifier 12 through resistor 13 serves as a current to voltage converter. The voltage signal from the output of operational amplifier 12 is carried via resistor 14 to the input of amplifier 15, which will amplify the signals from the sensor elements normally being pulses having the line frequency, e.g. 50 Hz, due to that the X-ray tube being supplied with such a pulsating high tension. Capacitor 17 together with resistor 16 acts as a filter to, for example, eliminate not wanted spikes but still preserve the amplified voltage pulses from amplifier 12. Amplifiers 12 and 15 in the preferred embodiment are situated at the substrate or on the circuit board at the rear side of the image sensing member together with the three sensor elements 2, 3 and 4 and thus constituting the interfacing unit portion 10.

From the electronic unit constituting the interfacing unit portion 10 the output signal is carried from amplifier 15 to the input of the interfacing unit portion 20, where it passes a

capacitor 21 and a resistor 22 presenting matching of the level and setting the point of operation to the input signal at amplifier 23. In the feed-back loop at the amplifier there is except resistor 24 a capacitor 25 with the purpose to supply a time constant somewhat larger than 20 ms, corresponding, in the preferred embodiment, to pulses at 50 Hz. Additionally there is a semiconductor diode 26 with the purpose to ensure that the negative pulses at the input of amplifier 23 do not exceed -0,7 V.

The signal from amplifier 23 is carried via an RC link 36, 27 to amplifier 28 having a high gain and acting as a comparator with a certain hysteresis, in other words a Schmitt trigger. Diodes 33 and 34 set forth the level of the output such that it at output A produces TTL level adjusted pulses between 0V and +5V.

From output A of the interfacing unit portion 20 the signal is carried to input A of the logic device 40. To simplify the description only a part of the logic device 40 has been demonstrated in detail in the schematic diagram. The signal is fed via a buffer 41 and into a monostable circuit created by logic circuits 42, 43, 44, 45, 49 and 50 which are parts of the larger logic device 40 of the special circuitry XC3030-44. From the internal input C is a signal "high" obtained by the monostable circuit, i.e. logic "one", during the period of time when the radiation hits any of the sensor elements 2, 3 and 4. When the radiation ceases and no more pulses are triggering the monostable circuit in the logic device 40, when the output of OR gate 50 goes low, i.e. the negative edge, at the next clock pulse via point 55 into the D-type flip-flop circuit 51, this will produce a signal "high" fed out via AND gate 52 and out to the internal output B as an indication that the detection of radiation has ceased.

Then the signals B and C are used to in a conventional way to control the rest of the electronics of, for example, the CCD cell such that when signal C goes "high" it temporary stops the

clocking of the CCD cell which then starts to integrate its image elements to produce an X-ray imaging of e.g. a tooth. When signal B later goes "high" as an indication of that the X-ray apparatus is deactivated, this signal B via the logic device 40 according to known technique starts the clocking of the CCD cell and the produced image is read out picture element by picture element and is fed to an ordinary graphic interfacing card in a standard personal computer (PC) according to the state of the art.

In a second preferred embodiment simultaneously the signal from the sensor elements is integrated, according to technique known of a person skilled in the art, to besides the above described triggering method also obtain a measure of the dose detected by the sensor arrangement 2, 3, 4 or as previously discussed the CCD device itself, and in this case this signal also controls at the same time the signal output B via a corresponding logic arrangement, such that when the stipulated X-ray dose for an appropriate exposure is received, the produced image from the image sensing member 5 is read out. Then in this alternative preferred embodiment a complete exposure automatics is obtained still without having to make any connection between the imaging arrangement and the X-ray source if the X-ray source was adjusted such that its minimum activated time period at least corresponds to the minimum time period necessary to get a satisfactory exposure of an X-ray image on the image sensing member 5.

In a third preferred embodiment the signal B is taken out externally and is used to control the X-ray arrangement, whereby the X-ray arrangement immediately is deactivated when the integration sets forth that sufficient dose for the exposure is received. In this case also an extra interfacing unit to the X-ray arrangement is needed, which is sensitive to the signal B and thus may control the external X-ray arrangement. This interfacing unit however is designed according to technique known of a person skilled in the art and the construction of that does not fall within the scope of the present invention.

The arrangement according to the present invention may of course in hardware be constructed in a number of different ways by using different components than what has been indicated here without deviating from the spirit, object and scope of the invention which is defined by the attached claims.

CLAIMS

1. A method for triggering of an X-ray imaging arrangement, comprising an X-ray source preferably for dental X-ray having a control device, an image sensing member (5) continuously emptied of dark current by clocking signals, a radiation sensitive sensor element, one or more electronic units for connection of the image sensing member to a personal computer having a display screen, characterized in detection of X-ray radiation by means of a sensor arrangement (2, 3, 4) comprising at least two sensor elements placed at the rear side of the image sensing member (5), the X-ray radiation sensed by the sensor arrangement (2, 3, 4) generating electric signals when the sensor arrangement is subject to X-ray radiation, and using a first electronic unit (10) in close proximity of the sensor arrangement (2, 3, 4) and preferably at the rear side of the image sensing member (5) to effectively buffer the electric signals obtained from said sensor arrangement.

2. A method for triggering of an X-ray imaging arrangement, comprising an X-ray source preferably for dental X-ray having a control device, an image sensing member (5) continuously emptied of dark current by clocking signals, a radiation sensitive sensor element, one or more electronic units for connection of the image sensing member to a personal computer having a display screen, characterized in detection of X-ray radiation by means of using the current to or from the CCD device due to the charging of the individual capacitors constituting the multitude of pixel elements which will be charged by the incident photons of the X-ray radiation and using a first electronic unit (10) preferably at the rear side of the image sensing member (5) to effectively buffer the electric current signals obtained from the CCD device.

3. The method according to claim 1, characterized in conversion of the signal from the sensor arrangement (2, 3, 4) by means of electronic units (10, 20, 40) into a first control signal (C) for

starting the generation of an X-ray image at the image sensing member (5) by in the electronic unit 40 keeping the clocking signals to the image sensing member (5) in a static state.

4. The method according to claim 2, characterized in conversion of the charging current signal achieved at the CCD device by means of electronic units (10, 20, 40) into a first control signal (C) for starting the generation of an X-ray image at the image sensing member (5) by in the electronic unit 40 keeping the clocking signals to the image sensing member (5) in a static state.

5. The method according to claim 3 or 4, characterized in generation of a second control signal (B) by means of the electronic units (10, 20, 40) when the X-ray radiation ceases for starting of the scanning of the image sensing member (5) and output of received image data from the scanning to the personal computer for storing of image data and simultaneous or later display of image data on the display screen and whereby the clocking signals to the image sensing member (5) in response to this signal no longer are kept in a static state.

6. The method according to claim 5, characterized in summing of the signals from the sensing of the X-ray radiation to generate a second control signal (B) starting the scanning of the image sensing member (5) when appropriate exposure is verified and output of received image data from the scanning to the personal computer for storing of image data and simultaneous or later display of image data on the display screen and whereby the clocking signals to the image sensing member (5) in response to this signal no longer are kept in a static state.

7. The method according to claim 4 or 5, characterized in feeding of the second control signal (B) from the electronic units (10, 20, 40) further to the control device of the X-ray source for deactivation of the X-ray source.

8. An arrangement for an X-ray device having electronic image sensing, comprising an X-ray source preferably for dental X-ray having a control device, an image sensing member (5) preferably of CCD type, a personal computer having a display screen and electronic units (10, 20, 40) between the image sensing member (5) and the personal computer, characterized in a sensor arrangement (2, 3, 4) comprising at least two sensor elements placed at the rear side of the image sensing member (5), the sensor arrangement (2, 3, 4) generating electric signals when it is subject to X-ray radiation and a first electronic unit (10) in close proximity of the sensor arrangement (2, 3, 4) at the rear side of the image sensing member (5) to effectively buffer the electric signals obtained from said sensor arrangement.

9. An arrangement for an X-ray device having electronic image sensing, comprising an X-ray source preferably for dental X-ray having a control device, an image sensing member (5) preferably of CCD type, a personal computer having a display screen and electronic units (10, 20, 40) between the image sensing member (5) and the personal computer, characterized in means for detection of X-ray radiation using the current to or from the CCD device due to the charging of the individual capacitors constituting the multitude of pixel elements which will be charged by the incident photons of the X-ray radiation and a first electronic unit (10) preferably at the rear side of the image sensing member (5) to effectively buffer the electric current signals obtained from the CCD device.

10. The arrangement according to claim 8, characterized in that the sensor arrangement (2, 3, 4) preferably is arranged at the rear side of the image sensing member (5) facing away from the X-ray source not to block the generated pattern in the image sensing member of picture elements produced by the X-ray radiation, forming the imaging of tissue or bone lying between the X-ray source and the image sensing member.

12. The arrangement according to any one of claim 8 to 10,

characterized in that the electronic unit (10) is sensitive to electric signals generated by the X-ray radiation and that the electronic units (10, 20, 40) then generate a first control signal (C) which via the third electronic unit (40) sets the image sensing member (5) in a mode starting the build-up of an image in said member, whereafter the picture elements produced in the image sensing member (5) due to the X-ray radiation in response of a second control signal (B) is scanned and transferred via the third electronic unit (40) into the graphic interfacing unit in the personal computer for storing and simultaneous or later display of image data on its display screen.

13. The arrangement according to claim 12, characterized in that the electronic unit, when the electric signals generated by the X-ray radiation cease, generates the second control signal (B) starting the scanning of the image sensing member, and after finishing the scanning the image sensing member operates in its idling state when it continuously is emptied of dark current.

14. The arrangement according to claim 13, characterized in that the electronic unit sums the electric signals generated by the X-ray radiation to achieve a measure of the amount of X-ray radiation, and the electronic unit when a predetermined adjustable dose is obtained generates the second control signal (B) starting the scanning of the image sensing member, and after finishing the scanning the image sensing member operates in its idling state when it continuously is emptied of dark current.

15. The arrangement according to claim 13 or 14, characterized in that the second control signal (B) is fed to and acts on the control device of the X-ray source via an interfacing device such that the X-ray source in this case immediately will be deactivated when the second control signal appears.

16. The arrangement according to any of claim 8 to 13, characterized in that at least one of the electronic units (10) is

locally arranged on the rear side of the image sensing member
(5).

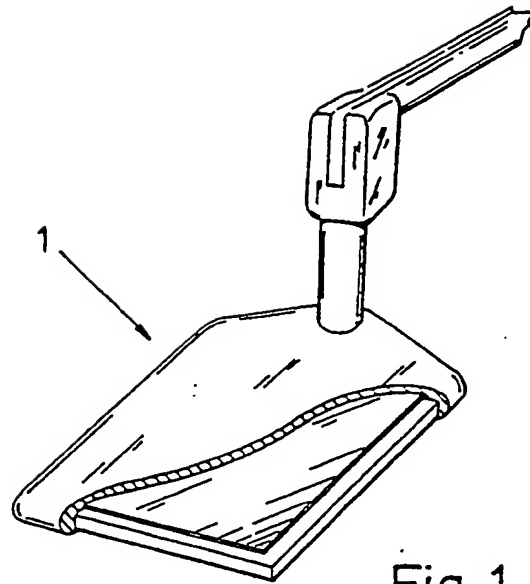


Fig. 1

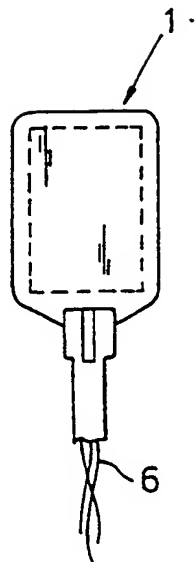


Fig. 2a

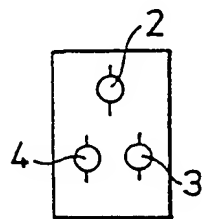


Fig. 2b

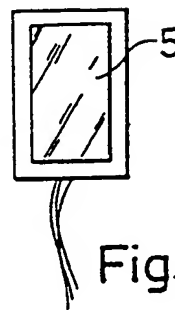


Fig. 2c

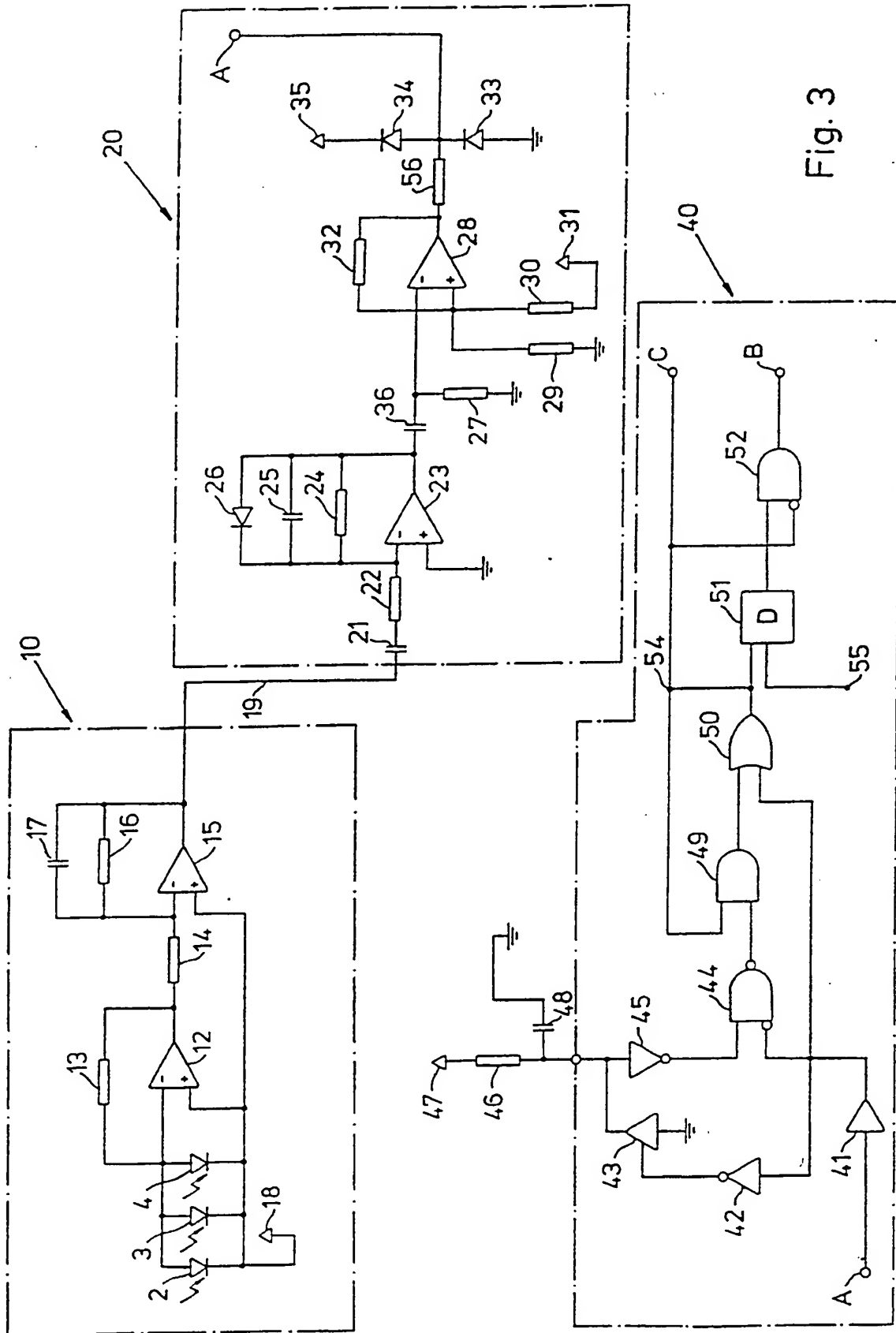



Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 92/00369

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC5: H 05 G 1/38; A 61 B 6/14; H 04 N 5/32		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC5	H 05 G, A 61 B, H 04 N	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in Fields Searched ⁸		
SE,DK,FI,NO classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
X	EP, A1, 415075 (SIEMENS AKTIENGESELLSCHAFT) 6 March 1991, see column 2, line 53 - column 3, line 32; figure 1; claims 1-7	9-10
Y	--	1-8, 11-16
Y	US, A, 4901336 (NISHIKIM.) 13 February 1990, see column 3, line 6 - line 51; figures 1-3; claims 1-2, 6	1-8, 11-16

<p>* Special categories of cited documents:¹⁰</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
3rd August 1992	1992-08-07	
International Searching Authority	Signature of Authorized Officer	
SWEDISH PATENT OFFICE	 Michael Felhendler	

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 92/00369

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
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